RO-20 Ion Chamber Technical Manual

Eberline
A subsidiary of
Thermo Instrument
Systems Inc.

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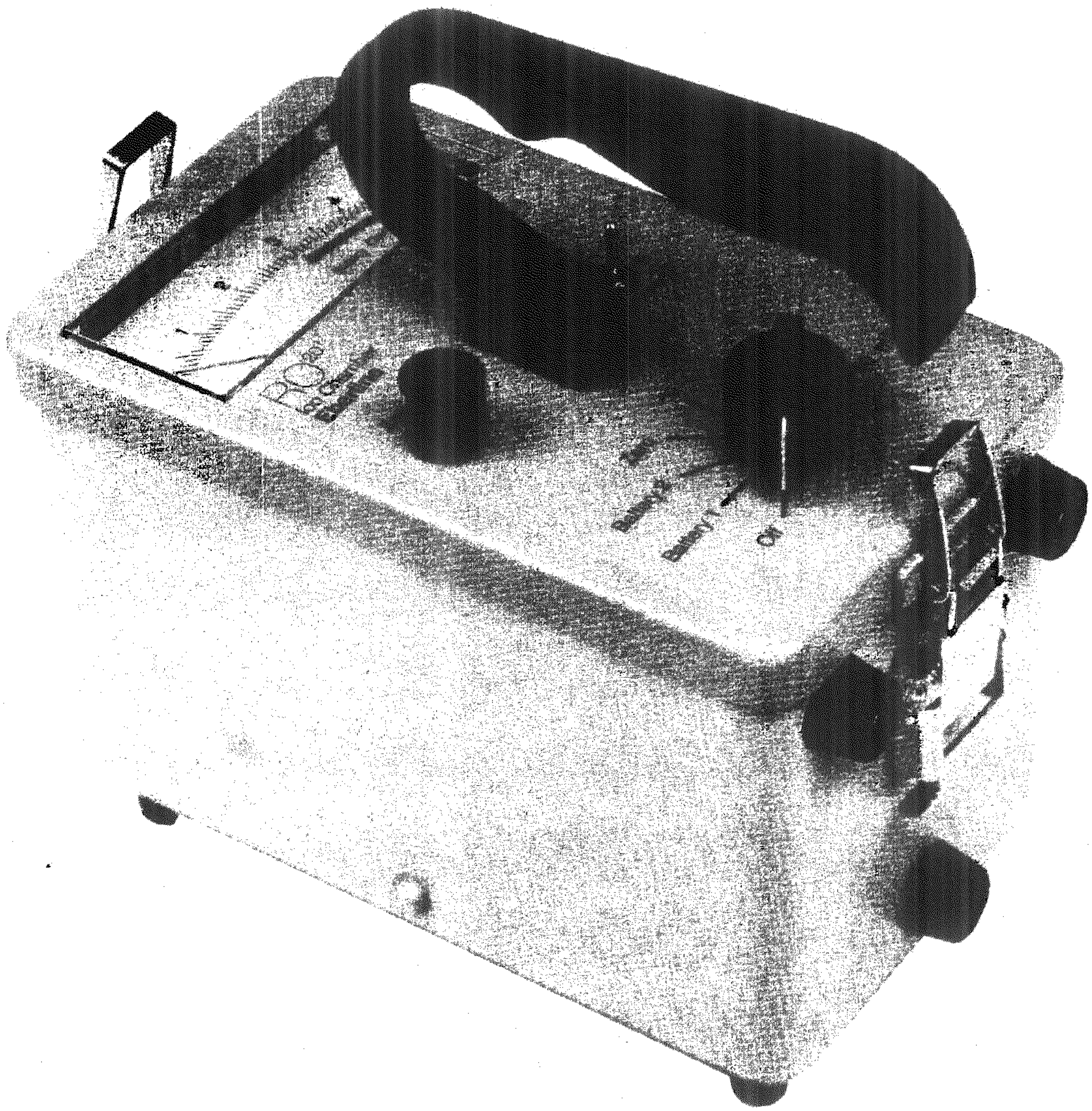

Figure 1-1. Model RO-20 Ion Chamber

SECTION 1
GENERAL

PURPOSE AND DESCRIPTION

The Model RO-20 is a portable air ion chamber instrument used to detect beta (ß), gamma (γ), and x-ray radiation. The RO-20 has five linear ranges of operation to measure exposure rate for x-ray and γ radiation. The ion chamber is vented to atmospheric pressure and is specifically designed to have flat energy response into the x-ray region.

The Model RO-20 is calibrated to γ radiation (^{137}Cs).

A single rotary switch turns the instrument off, provides battery checks, checks the zero setting, and selects the range of operation.

SPECIFICATIONS

Detector

Size

2.84 inch inside diameter, 13.4 in^3 volume (7.21 cm dia., 220 cm^3).

Fill

Air, vented to atmospheric pressure.

Wall

0.20 in. (0.51 cm) conductive plastic approximately 640 mg/cm^2 inside 0.063 inch wall aluminum case, making approximately 1000 mg/cm^2 total thickness.

Window

Two layers (one on the chamber, one on the can) 0.001 inch (25 micron) mylar, approximately 7 mg/cm^2 total.

Beta Shield

Sliding shield on bottom of case with positive friction lock. Approximately 1000 mg/cm^2 (5/16 inch phenolic).

Radiation Detected

Beta, gamma, and x-ray.

Photon Energy Response (See Figure 1-2)

In the following examples, the RO-20 had been calibrated to ^{137}Cs, slide closed, with the slide facing the source.

$\pm$30% from 8 keV to 1.3 MeV with the open slide facing the source.

$\pm$15% from 33 keV to 1.3 MeV with the closed slide facing the source.

$\pm$15% from 55 keV to 1.3 MeV through the side of the instrument.

Examples of Beta Response

Uranium Slab
30% of true mrad/h field behind 7 mg/cm^2 window with RO-20 resting on slab, slide open.

^{90}Sr-^{90}Y
Approximately 93% of true mrad/h field at 30 cm with slide open.

Fast Neutron Response (PuBe)

Reads approximately 8% in mR/h of true neutron field in mrem/h.

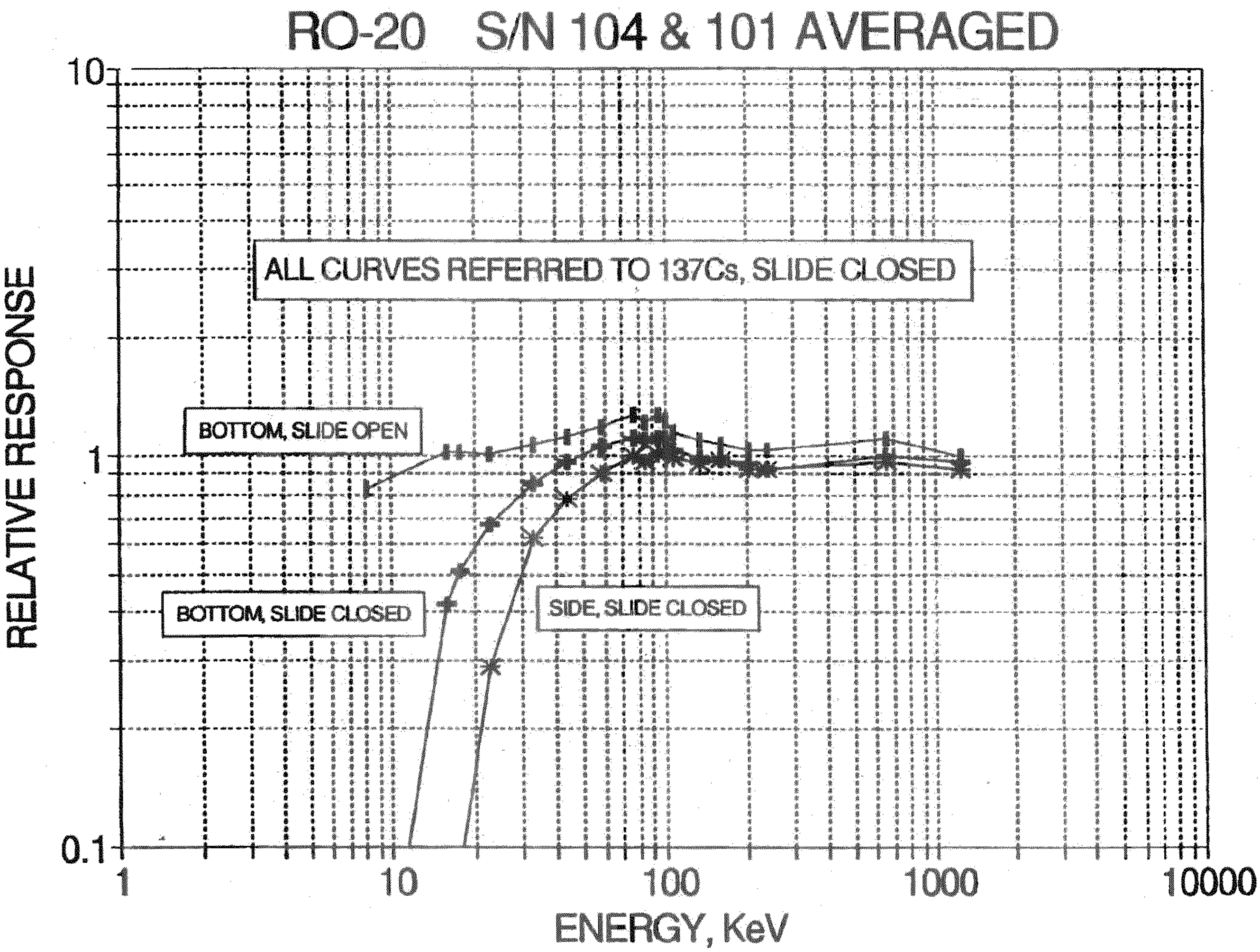

Figure 1-2. Nominal Photon Energy Response

General

Ranges

Five linear ranges: 0-5, 0-50, 0-500 mR/h and 0-5, 0-50 R/h.

Meter

Scale length, approx. 3 inches (7.6 cm), 2% accuracy. Linear markings from 0 to 5 in 50 minor increments. The meter is back lighted.

Response Time

5 seconds, 0 to 90% of final reading.

Linearity

Within ± 5% of full scale.

Battery Dependence

Reading is independent of battery voltage when the battery check indications are in the green arc.

Controls

External

Range switch, including *Off*, *Zero*, and Battery checking positions.

Zero knob used to set meter to zero when *Zero* position of range switch is selected or when in no significant radiation field.

Light switch, for meter light.

Internal

Five calibration controls, one for each range.

Batteries

Main power: Five "C" cells.

Chamber bias: Ten 3 volt lithium coin cells, 30 volts.

Life: "C" cells, widely variable according to RO-20 usage and battery type.

Typical ZnC: mR/h ranges, 2900 hrs. All other ranges, 150 hrs.

Typical Alkaline: mR/h ranges, 6900 hrs. All other positions, 350 hrs.

Frequent or continuous use of the light will reduce battery life significantly.

Thirty volt chamber bias battery life: Totally dependent upon the usage of "Battery 2" position of the range switch. The battery capacity should allow for at least 50,000 five second battery checks. The battery drain is negligible on all other positions of the range switch.

Environment

Temperature

Operable from -40°F to 140°F (-40°C to 60°C). For operation below 0°F (-18°C), alkaline or nickel-cadmium "C" cells should be used.

Temperature Compensation

The detector is fully compensated over the operational temperature range for output accuracy within 10% ± 0.5 mR/h.

Moisture

Seals used at openings for dust and water resistance. Detector is protected by a silica-gel dryer.

Humidity

Operable from 0 to 95%, non-condensing.

Weight

Approximately 3.6 pounds (1.63 kg) with alkaline C cells.

Size

4.2 inches wide x 7.9 inches long x 7.7 inches high (10.7 cm x 20.1 cm x 19.6 cm), including handle.

SECTION 2
OPERATION

DESCRIPTION OF CONTROLS

Function Switch

Nine position rotary switch that turns the instrument off, checks the condition of the batteries, checks instrument zero, and selects the range of operation to be used.

Zero Knob

Used to set the meter to zero when the *Zero* switch position is selected or when in an insignificant radiation field.

Light Switch

Illuminates the meter. Has three positions, *Off*, *Momentary*, *On*.

Calibration Controls

(Internal) Five variable resistors, one for each range.

USING THE INSTRUMENT

- CAUTION -

The higher radiation field strengths measurable by the RO-20 can cause personal injury in a short time.

Before using the instrument Check *Battery* 1 (C cells) and *Battery* 2 (lithium cells). The meter should indicate in the green Battery Check arc. Do not leave the switch in the *Battery 2* position for an extended period of time.

Turn the function switch to the *Zero* position. Check that the meter reads zero. If not, set it to zero with the *Zero* knob.

Set the function switch to the desired range of operation. The switch position selected is the full scale reading of that range.

When measuring ß, low energy γ, or x-ray emissions, open the sliding ß shield on the bottom of the case and face the bottom of the instrument toward the radiation source. To open or close the shield, depress the friction release button on the left side of the case and manually move the slide, or let it fall due to gravity. When the shield is open, protect the thin face against puncture damage.

OPERATING NOTES

The zero setting of the instrument may be checked in any radiation field by merely selecting the *Zero* position.

When switching from the R/h ranges to the mR/h ranges, transient noise may cause a temporary deflection of the meter. This can be minimized by first selecting 500 mR/h, letting the needle settle, and then switching to the lower ranges.

The effective center of the ion chamber is marked by dimples at the front and sides of the instrument.

Since the ion chamber is vented to the atmosphere, it is sensitive to changes in atmospheric pressure. Table 2-1 and 2-2 (on the following pages) give correction factors to be applied if the RO-20 is used at an elevation other than that when calibrated. Normal atmospheric pressure variations at one location are small enough to be ignored.

The chamber output signal is fully temperature compensated. No additional temperature correction is necessary.

The RO-20 will not be damaged by exposing the instrument to radiation fields which exceed the full scale level. Extreme overexposure may cause a minor shift of the zero position and a small temporary offset on the most sensitive range. Resetting the *Zero* control may be necessary.

If a minor offset from zero exists on the most sensitive range when in a known insignificant field, the *Zero* control may be used to remove the offset. *Zero* need not be reset when using the higher ranges.

The chamber bias battery holds the electronic circuitry at 30 volts negative with respect to chassis potential. Do not short any part of the circuitry to the chassis parts or damage may occur.

Table 2-1. Altitude Corrections, Feet

		ALTITUDE WHEN CALIBRATED										
		SEA LEVEL	1000'	2000'	3000'	4000'	5000'	6000'	7000'	8000'	9000'	10,000'
	SEA LEVEL	1	0.96	0.93	0.90	0.86	0.83	0.80	0.77	0.74	0.71	0.69
ALTITUDE WHEN USED	1000'	1.04	1	0.96	0.93	0.90	0.86	0.83	0.80	0.77	0.74	0.71
	2000'	1.08	1.04	1	0.96	0.93	0.89	0.86	0.83	0.80	0.77	0.74
	3000'	1.12	1.08	1.04	1	0.96	0.93	0.89	0.86	0.83	0.80	0.77
	4000'	1.16	1.12	1.08	1.04	1	0.96	0.93	0.89	0.86	0.83	0.80
	5000'	1.20	1.16	1.12	1.08	1.04	1	0.96	0.93	0.89	0.86	0.83
	6000'	1.25	1.20	1.16	1.12	1.08	1.04	1	0.96	0.93	0.89	0.86
	7000'	1.30	1.25	1.20	1.16	1.12	1.08	1.04	1	0.96	0.93	0.89
	8000'	1.35	1.30	1.25	1.21	1.16	1.12	1.08	1.04	1	0.96	0.93
	9000'	1.40	1.35	1.30	1.25	1.21	1.16	1.12	1.08	1.04	1	0.96
	10,000'	1.45	1.40	1.35	1.30	1.26	1.21	1.17	1.12	1.08	1.04	1

Multiply Meter Reading By Given Correction Factor

Table 2-2. Altitude Corrections, Meters

		ALTITUDE WHEN CALIBRATED (METERS)													
		SEA LEVEL	250M	500M	750M	1000M	1250M	1500M	1750M	2000M	2250M	2500M	2750M	3000M	3250M
	SEA LEVEL	1	0.97	0.94	0.91	0.89	0.86	0.83	0.81	0.78	0.76	0.73	0.72	0.69	0.67
ALTITUDE WHEN USED (METERS)	250M	1.03	1	0.97	0.94	0.91	0.89	0.86	0.83	0.81	0.78	0.76	0.74	0.72	0.69
	500M	1.06	1.03	1	0.97	0.94	0.91	0.89	0.86	0.83	0.81	0.78	0.76	0.74	0.72
	750M	1.10	1.06	1.03	1	0.97	0.94	0.91	0.89	0.86	0.83	0.81	0.78	0.76	0.74
	1000M	1.13	1.10	1.06	1.03	1	0.97	0.94	0.91	0.89	0.86	0.83	0.81	0.78	0.76
	1250M	1.16	1.13	1.10	1.06	1.03	1	0.97	0.94	0.91	0.89	0.86	0.83	0.81	0.78
	1500M	1.20	1.16	1.13	1.10	1.06	1.03	1	0.97	0.94	0.91	0.89	0.86	0.83	0.81
	1750M	1.24	1.20	1.16	1.13	1.10	1.06	1.03	1	0.97	0.94	0.91	0.89	0.86	0.83
	2000M	1.28	1.24	1.20	1.16	1.13	1.10	1.06	1.03	1	0.97	0.94	0.91	0.89	0.86
	2250M	1.32	1.28	1.24	1.20	1.16	1.13	1.10	1.06	1.03	1	0.97	0.94	0.91	0.89
	2500M	1.36	1.32	1.28	1.24	1.20	1.16	1.13	1.10	1.06	1.03	1	0.97	0.94	0.91
	2750M	1.40	1.36	1.32	1.28	1.24	1.20	1.16	1.13	1.10	1.06	1.03	1	0.97	0.94
	3000M	1.44	1.40	1.36	1.32	1.28	1.24	1.20	1.16	1.13	1.10	1.06	1.03	1	0.97
	3250M	1.49	1.44	1.40	1.36	1.32	1.28	1.24	1.20	1.16	1.13	1.10	1.06	1.03	1

Multiply Meter Reading By Given Correction Factor

SECTION 3
THEORY OF OPERATION

GENERAL

Refer to Figure 3-1, a block diagram representing the basic operation of the circuit. The ion chamber structure is maintained at chassis potential while all the other circuitry is held at minus 30 volts by the 30 volt bias battery. When the air in the chamber ionizes due to radiation, a minute current flows from the chamber wall to the center electrode, causing the minus input lead of the first operational amplifier to go very slightly positive.

This results in a negative swing of the amplifier output which is connected to the feedback elements through a temperature compensating divider circuit. The feedback elements are connected to the amplifier input and to the ion chamber and they conduct away all of the current generated in the ion chamber. The second amplifier stage, which is fed from the first amplifier, drives the meter through calibrating adjustable resistors. The gain of the second stage is controlled by the range switch so that the full scale output from the second stage is nearly constant for all ranges.

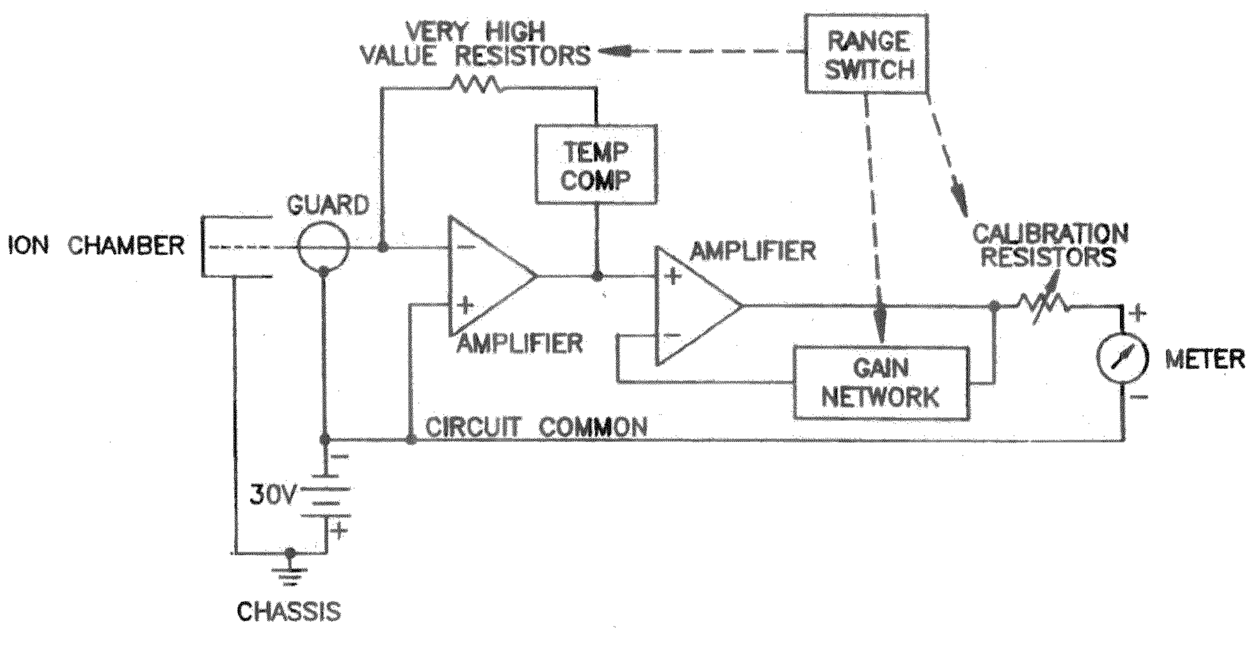

Figure 3-1. System Block Diagram, 11498-B23

A common line is used as a reference for all the electronic circuits. This common line is held approximately 30 volts negative with respect to the instrument chassis.

FUNCTIONAL THEORY

Ion Chamber

The ion chamber is located inside the case below the meter. It consists of the lower two inches of the three inch diameter chamber assembly. The remainder of the volume contains electronic components. The chamber wall is 0.20 in. (0.51 cm) thick conductive plastic and the face is one mil (25 micron) aluminized Mylar. Another one mil Mylar layer is glued to the bottom of the case, making the total thickness two mils, a total of approximately seven mg/cm'. The active volume of air in the chamber is approximately 220 cin.

The entire chamber, which is made of conductive plastic, is maintained at chassis potential. The inside of the Mylar face is also at the same voltage. The center electrode is coated with conductive graphite and is supported on the center conductor of the guarded feedthrough at the top of the chamber. The guard ring of the guarded feedthrough is positioned on insulators between the center conductor and the outer ring to prevent leakage from the chamber voltage to the center electrode. The guard ring and center electrode are maintained at the same potential (common potential) to prevent leakage from the guard to the electrode.

The chamber is sealed but vented through a plastic tube to a silica gel desiccant package. A small hole connects the chamber to the electronic section above the chamber. In this way, any air drawn into the chamber (caused by atmospheric pressure changes, temperature changes, transporting the RO-20 by air, etc.) must first pass over the drying desiccant. Dry air in the chamber is essential to help prevent current leakage.

An idealized air chamber, the size of the one used on the Model RO-20, produces a little over 2xlO-" amps per mR/h at the standard temperature and pressure of 0 oc and 760 mm of Hg. At 5 mR1h it should produce 1XIO-13 amps and at 50 R/h it should produce lxlO-' amps. It is seen that at full scale on the most sensitive range (5 mR/h), about one-tenth of a micromicroamp is produced in the chamber, which makes protection against leakage currents paramount. The silica gel desiccant should be changed as soon as it shows clear or pink crystals.

,The amount of ion current produced depends upon the intensity of the radiation field and the density of the air in the chamber. The density depends on the temperature and pressure of the air. A temperature sensing compensation circuit corrects for the change in ion current due to temperature changes, leaving only the pressure effects to be considered external to the instrument. Tables 2-1 and 2-2 present correction factors useful when the elevation at calibration is different from the elevation during usage. Normal atmospheric pressure variations at any one location are small enough to be ignored.

A voltage gradient must exist across the ion chamber in order to move the ions, producing the ion current to be measured. All of the chamber structure is maintained at chassis potential, but the center electrode disk and all the remaining circuitry is biased at minus 30 volts, relative to the chassis. A 30 volt lithium battery provides this voltage. Except for insulation leakage and the very few microamps taken during battery check, the 30 volt battery is essentially open circuited and will last indefinitely long.

Circuit Description (See Figure 6-1)

The first stage of operational amplifier A101 is connected to the ion chamber. Also connected to the chamber are the elements in the feedback loop consisting of two high value resistors, a reed relay and a capacitor. The switching in the loop is done by two reed relays. One of the relays is used to short out the components so that any voltage offset may be adjusted out with the zero knob. That relay is closed when in the two battery check positions (to provide maximum battery load) and in the Zero position of the range switch. It is open in the other switch positions.

When operating on the two R/h ranges, K102 is pulled in to place R102, the 1.5 gigaohm resistor, in the circuit. The higher ion currents develop sufficient voltages for operation with this smaller resistor. When using the mR/h ranges, both relays are open, leaving R101, the 150 gigaohm resistor, as the feedback element. The feedback signal to the two high value resistors comes from the temperature compensation circuit made up of R105, R106, R107 and RT101. C102 is a time constant component used to set the response time.

The relays consume about ten times more power than the total of the rest of the circuits (except the lamps) and since no relays are pulled in on the three mR/h ranges, the battery life is very long if only these ranges are used.

The second stage of A101 amplifies the output of the first stage and then drives the meter circuit. The gain of the second stage is set according to the range switch position. Each range has a separate calibration control, an adjustable resistor in series with the second stage output. This circuit then feeds the meter directly through the range switch.

The Zero control provides a slight voltage offset adjustment to the input of the first stage of A101. The amplifiers are DC coupled and this adjustment is reflected at the meter.

Component A203 is a five volt regulator. Its output is connected to A202, a component called a rail splitter. It produces a voltage exactly one half of that which is impressed across it. The voltage it produces is called "common" and this potential is used as a reference for the rest of the electronic circuits. The negative end of the lithium battery pack is connected to common, holding common 30 volts negative with respect to the chassis. The positive terminal, of the meter is connected directly to common so all meter up-scale indications must come from a source more negative than common. When checking the C cells, amplifier A201-8,9, 10 is used to reflect the opposite polarity of the C cell battery's positive end. When checking the lithium battery, amplifier A201-12,13,14 is used to reflect the opposite polarity of the input from the more positive chassis potential.

Amplifier A201-1,2,3 is used to hold the relay coils at common potential whenever the relays are not actuated. This helps to reduce leakage currents when using the mR/h ranges. Amplifier A201-5,6,7 provides a slow reduction of relay coil current when switching to the mR/h ranges in order to minimize transients.

SECTION 4
MAINTENANCE

PREVENTATIVE MAINTENANCE

Batteries

Replace the "C" cells when *"Battery 1"* check indicates near the left end of the green arc. (Keep and reuse the battery insulating tubes when replacing the "C" cells.) Replace the lithium battery when *"Battery 2"* indicates at the left end of the green arc. (The lithium cells should last several years. They run down exceedingly slowly. Do not prematurely replace them.) Observe the polarity indicators when installing the batteries.

Remove the "C" cells if the instrument is to be inactive for a long period of time.

- CAUTION -

Many of Eberline's instruments contain alkaline, carbon, lead, nickel-cadmium or lithium batteries. All batteries contain small amounts of heavy metals and other hazardous materials and must be handled and disposed of properly. Lithium batteries present the following hazards; fire, explosion, or severe bum risk. Do not expose the cell contents to water. Recharge only batteries specifically designated as rechargeable and follow the manufacturers recommendations on recharging. Do not puncture, mutilate, or attempt to disassemble, incinerate, or heat above 100*C (212*F). Eberline recommends that all batteries be recycled at appropriate licensed recycling centers or disposed of as required by local ordinances and

Desiccant

Replace the desiccant package when the crystals begin to turn clear or pink in color. Slip the hose from the fitting on the old desiccant pack and onto the new one. The used silica gel crystals can be repeatedly dried by heating to 250 degrees F (120 degrees Q for twelve hours or to 400 degrees F (205 degrees Q for one hour. Keep dried crystals in tightly-sealed containers until ready for use. The snap-on cap of the desiccant package has a small hole in it to allow the air to move through it. Make sure this hole is not covered or clogged.

- NOTE -

It is very important that the inside of the chamber assembly be kept dry to avoid leakage currents due to moisture. If the desiccant becomes saturated and the unit becomes erratic due to moisture, renew the crystals and cycle the instrument between room temperature (or lower) and + 140* F three or four times to flush the chamber air across the desiccant.

CALIBRATION

For maximum accuracy,, the RO-20 should be calibrated at approximately the same air pressure as is expected for its use. If the conditions for calibration and for use are necessarily different, an offset may be used during calibration so that the instrument will read properly when put to use. Table 2-1 or 2-2 can be used to select the proper offsets in this case. Interpolate where appropriate.

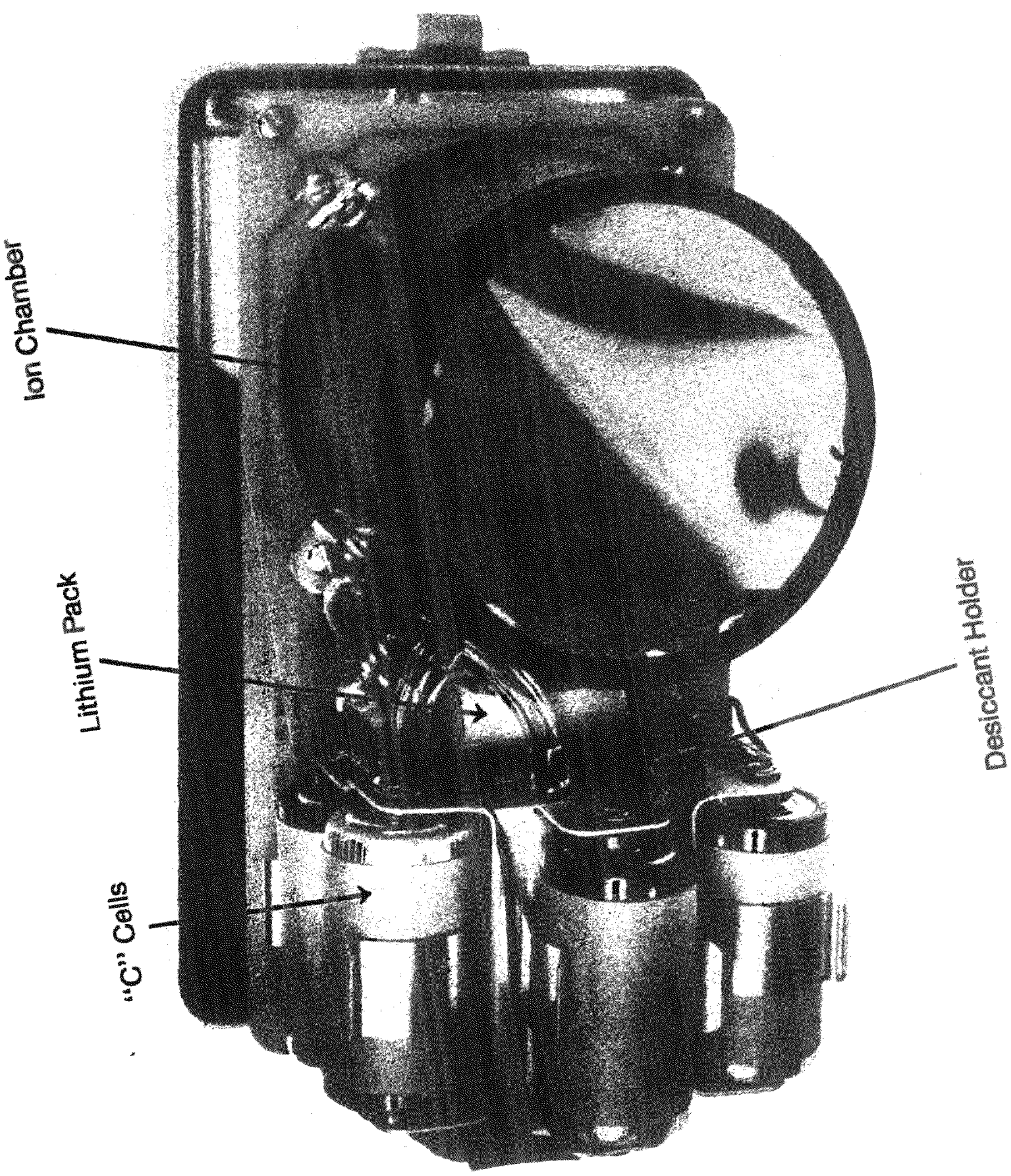

Figure 4-1.. Interior View, RO-20

- CAUTION -

The higher radiation field strengths required for calibration of the RO20 can cause personal injury in a short time. Use safe procedures.

To calibrate, first select the Zero position and zero the meter. Remove the plastic cover on the side of the can and position the RO-20 so that the ion chamber is in a gamma field of known intensity. Adjust the calibration control (corresponding to the range switch position) for the proper meter indication. For best accuracy, choose a calibration field which will cause the meter to read near the 4 mark when calibrated. Repeat the procedure for all five ranges. To avoid errors, the entire ion chamber of the RO-20 must be in the gamma field when calibrating. The effective center of the chamber is marked by indentations at the front and sides of the case. Reinstall the plastic cover in the side of the can when finished.

CIRCUIT CHECKS

Operate the light switch, both directions, and observe that the lamps operate.

Select *Battery* I position and measure the voltage of the "C" cells. Multiply the voltage by 0.64 and then subtract 0.43. The meter should indicate this amount, within 5

Select *Battery* 2 position and measure the voltage of the lithium pack. The meter should indicate battery voltage multiplied by 0. 114, within 5

DISASSEMBLY

The lower case can be separated from the assembly by unfastening the front and rear latches and lifting the instrument from the case.

The chamber face is very thin and easily damaged. If the case is to be off *for an extended period of time,*

Static sensitive components are used on both the main circuit board and on the chamber board. Use grounding procedures to eliminate static charges when working on the RO-20.

The lithium battery holds the circuit components at 30 volts negative with respect to the chassis. Never short any circuit point to chassis or damaged components may result.

To remove the chamber face, pry off the clamp ring and lift off the face.

To remove the chamber assembly, push the desiccant package rearward and separate the hose from the desiccant package. Loosen (or remove) the four screws holding the chamber and rotate it until it is free. Unplug the cable from the chamber. When the chamber electronic section is exposed, it is best to short the center pin of the guarded feedthrough to the guard ring to prevent static damage to the amplifier. Never short any part of the chamber circuit to the chamber body or damage to the components may result.

To remove the small battery/connector board from the chamber, remove the two screws and gently pull the board from the chamber. As soon as it can be reached, hold the cable connector and unplug it from the battery/connector board: (Handle the cable gently.) Remove the board and keep it insulated to protect the battery.

To remove the center electrode disk from the chamber, gently unplug the cable between the chamber board and the small battery board. This will remove the 30 volt bias between the disk and the chamber walls. With pliers, hold the center pin in the electronics section to keep it from turning and unscrew the disk. Two small holes in the disk are provided to help rotate it.

To remove the chamber board assembly, gently unplug the cable which connects it to the battery board. Unsolder the connections to the guarded feedthrough assembly. Remove the three nuts holding the board and lift it out.

To continue for total disassembly of the chamber, remove the three nuts and screws holding the metal cup in place. Lift out the cup and the insulating disk. The three nylon shoulder washers may be pushed out if desired. Unscrew the guarded feedthrough to finish the disassembly.

To remove the "C" cell battery bracket assembly, remove the batteries and remove the desiccant package. Unplug the two main board connections, remove the four screws holding the chassis to the board spacers and lift it off.

To separate the main board from the cover, unplug the cable between the board and the cover. Remove the knob from the range switch and remove the nut from the switch bushing. Remove the two screws from the long standoffs at the front of the board and pull the cover and the board apart. The light switch pins will slip out of the connector.

To remove the meter, unsolder the wires from it. Remove the two nuts and washers and remove the two long hexagon shaped spacers at the front. Remove the meter retainer and lift out the meter.

The slide, the slide holder and the feet may be removed from the can by removing the four nuts and screws which hold them.

REASSEMBLY

In general, for reassembly reverse the procedure used in disassembly.

The aluminized Mylar face on the bottom of the can is one mil (.001 inch) (25 microns) thick. It is glued to the can using electrically conductive adhesive. If only one side of the Mylar is coated with aluminum, that side must be against the can.

The slide is not completely symmetrical. When properly installed, the front edge of the slide is even with the edge of the slide holder when the slide is fully closed. When the slide is fully opened, the back of the slide sticks out past the back of the holder.

Adjust the slide release mechanism so that a slight movement of the release button will free the slide. The adjustment is made by moving the two stop nuts (which press against the spring) up or down on the long screw which presses against the slide.

To install a meter, slip it over the studs in the cover, put on the flat washers, the lockwashers and lightly tighten the nuts to prevent fracturing the meter plastic. Place the meter retainer over the studs at the front of the meter and, while pressing the retainer back against the meter, tighten the hex spacers on the studs.

When reassembling the cover and main board together, guide the three light switch pins into the mating connector. When installing the knob on the range switch, make sure it is oriented properly.

If the chamber was highly disassembled, the following may be used as a guide:

a. Screw in the guarded feedthrough from the top of the chamber assembly.

b. Press the three nylon shoulder washers into the holes in the chamber plate. The widest washer diameter must be on the chamber side.

c. Insert the three screws from inside the chamber up through the nylon washers. Hold them in place.

d. Place the insulating disk over the three screws.

e. Place the metal cup over the three screws. Make sure the opening matches the opening in the chamber.

f. Install lockwashers and nuts on the screws. Tighten firmly.

g. With an ohmmeter, check that a complete open circuit exists between the metal cup and the body of the chamber.

h. Screw the center electrode disk onto the center pin of the guarded feedthrough. The s / mall diameter hub goes toward the electronic section. Hold the center pin with a pair of pliers and tighten the disk.

i. Install the chamber circuit board and fasten it with lock washers and nuts. Solder in the connections to the guarded feedthrough.

j. Gently plug the cable onto the battery/connector board and fasten the board to the chamber with the screws and lockwashers.

k. Use one mil (0.001. inch) (25 micron) aluminized Mylar for the chamber face. If only one side has aluminum on it, make sure that side is toward the inside of the chamber. Lay the Mylar on the chamber and slip the clamp ring over it, making as smooth a face as possible.

TROUBLESHOOTING

The schematic diagram, Figure 6-1, the system block diagram, Figure 3-1, and Section III, Theory of Operation are the primary aids to troubleshooting.

Make sure the batteries check OK.

The RO-20 has only' four active circuit components, amplifiers A101 and A201, the voltage regulator A203 and the reference divider A202. A quick check with a voltmeter will determine if the outputs of A203 and A202 are proper. The two amplifiers are in sockets for easy substitution. (Pin 2 of A101 is bent outward to avoid touching the socket. It is solder connected. It or a new component must be re-installed the same way for air insulation.) If substituting new amplifiers does not solve the problem, then tracking the circuit functions must be performed to find the fault.

Several components connect to the point in the circuit where the extremely small ion chamber current flows. It is of the utmost importance that they be clean, free of fingerprints and carefully installed. They include pin 2 of A 101, the two feedback resistors R101 and R102, relays K101 and K102, and C102. The critical leads of these components are not supported on insulators. They are air insulated at all points. Pin 2 of A101 is not inserted in the socket but is bent outward so as to not touch the socket.

If leakage currents appear to be a problem, make sure the desiccant is dark blue. Temperature cycling as described earlier in this section may correct the problem. The use of a high purity, mild Freon solvent spray to clean the high impedance components may help. Do not use alcohol spray on the center electrode disk since it will dissolve the conductive aquadag coating.

SECTION 5
PARTS LIST

The following table lists the electronic items incorporated in the RO-20 and should contain any part necessary for normal electronic repair. Unless otherwise specified, callouts of manufacturers and manufacturers' part numbers are to be considered typical examples only. There are no restrictions against using equivalent parts with the same operating characteristics. When ordering parts from Eberline, specify instrument model number, serial number, reference designation, value, Eberline part number, or a word description if the part has no reference designation. Eberline will automatically substitute equivalent parts when the one called out by the manufacturers' part number is no longer available.

REF. DESIG	PART	DESCRIPTION	MANUFACTURER AND PART NO.	EBERLINE PART NO.
1. Basic RO-20				
M1	Meter	200 μA	Modutec 01-130120	MTPA35
P1	Connector	Housing, 5-pin	Molex 09-05-7051	COMR205
	Contacts	Contacts for P1	Molex 08-56-0106	COHD71
P2,P3	Receptacle	Battery Conn.	Faston 61060-1	TEQC2
R1	Potentiometer	Zero Control	Clarostat CM-46941	PTCC104B23
S1	Toggle Switch	Light Switch	CK 7107-S-D-W1-B-E	SWTO39
		Handle	Eberline	ZP10448011
		Range Knob	Rogan RB-67-2-B-M	HDKN25
		Zero Knob	Raytheon 50-1-1	HDKN4
		Zero Knob Guard	Eberline	ZP10894010
		Desiccant Pack	Eberline	YP11498021
		Can Assembly	Eberline	YP11502001
		Can Hole Plug		MMBZ23
2. RO-20 Main PC Board Assy. YP11546002				
A201	Amplifier	Quad Mos Input	National LPC660AIN	ICAOAPC660
A202	Voltage Divider	Rail Splitter	T.I. TLE2426CLP	ICAVA2426P

REF. DESIG	PART	DESCRIPTION	MANUFACTURER AND PART NO.	EBERLINE PART NO.
A203	Voltage Regulator	Micropower Volt Reg	National LP2950CZ	ICAVA2950C
C201,C202	Capacitor	22 MF 15V, 20%	Sprague 196D	CPTA220M4H
C203	Capacitor	1.0 MFD-35V, 10%	Sprague 196D	CPXX11
CR201, CR202,CR203	Diode	1N4148		CRSI1N4148
DS201,DS202	Lamp	PL-2, Indus. Type 2#		LPBU13
J201		10 Pin Receptacle	Samtec TMS-110-01-G-S	COMR510
J202		5 Pin Receptacle	Molex 09-60-1051	COMR305
J203		3 Pin Recept.	Molex 09-52-3033	COMR1003
J204,J205		Single Tab	AMP Faston 61134-1	TEQC3
R201	Resistor	1K, 1%	RN50D	RECE102B11
R202	Resistor	36.5K, 1%, 1/4W	RN55D	RECE363B12
R203	Resistor	3.32K, 1%, 1/4W	RN55D	RECE332B12
R204	Resistor	100K, 1%, 1/10W	RN50D	RECE104B11
R205,R206, R208	Resistor	10M, 1%, 1/4W	RN55D	RECE106B12
R207,R210	Resistor	8.25K, 1/4W, 1%	RN55D	RECE822B12
R209	Resistor	562K, 1%, 1/4W	RN55D	RECE564B12
R211	Resistor	5.11K, 1%, 1/4W	RN55D	RECE512B12
R212-R216	Potentiometer	10K, Multiturn	Spectrol 64X	PTCE103B93
R217	Resistor	200K, 1%, 1/4W	RN55D	RECE204B12

REF. DESIG	PART	DESCRIPTION	MANUFACTURER AND PART NO.	EBERLINE PART NO.
R218	Resistor	221K, 1%, 1/4W	RN55D	RECE224B12
R219	Resistor	86.6K, 1%, 1/8W	RN50D	RECE863B11
R220,R221	Resistor	1 MEG, 1%, 1/10W		RECE105B11
R222	Resistor	118K, 1%, 1/8W	RN50D	RECE114B11
R223	Resistor	51.1K, 1%, 1/4W	RN55D	RECE513B12
S201	Rotary Switch			SWRO57
XA201	Socket	14 Pin Dip	T.I. Augat C93-14-02	SOIC114
3. RO-20 Detector Board Assy. YP11547002				
A101	Amplifier	Dual MOS Input	National LPC662AIN	ICAOAPC662
C101	Capacitor	10MF-16VDC, 20%	Sprague 196D	CPTA100M4X
C102	Capacitor	4.7pF-1KV, 5%	Sprague 10TCC-V47	CPCE472F2U
C103	Capacitor	.1MF-50V, 10%	Centralab CW20C104K	CPCE104P3N
CA101	Cable	1 Conn., 10 Pin	Samtec FSS-10-S-G-02-ST8	VECA10
CR101,CR102	Diode	1N4148		CRSI1N4148
K101, K102	Relay	5V, 10mA		RLRD1
R101	Resistor	1.5×10^{11} ohms	HYMEG HA-650	REHV151G34
R102	Resistor	1.5×10^{9} ohms	HYMEG HA-65	REHV158B2X
R103	Resistor	226 ohm, 1%, 1/10W	RN50D	RECE221B11
R104	Resistor	51.1K, 1/10W, 1%	RN50D	RECE513B11
R105,R108	Resistor	10K, 1%, 1/4W	RN55D	RECE103B12

REF. DESIG	PART	DESCRIPTION	MANUFACTURER AND PART NO.	EBERLINE PART NO.
R106	Resistor	100K, 1%, 1/4W	RN55D	RECE104B12
R107	Resistor	12.1K, 1%, 1/8W	RN55D	RECE123B11
R109	Resistor	332K, 1%, 1/4W	RN55D	RECE334B12
R110	Resistor	3.01K, 1%, 1/4W	RN55D	RECE302B12
RT101	Thermistor	10K, 10%	Fenwal FA41J1	RETT103B3X
XA101	Socket	8 Pin Dip	T.I. Augat C93-08-02	SOIC308
XK101,XK102	Socket	5 Pin, Right Angle		SOIC105
4. RO-20 Connector Board Assy. YP11548002				
J301,J302		10 Pin, Receptacle	Samtec TMS-110-01-G-S	COMR510
BT301	Battery	10 Lithium Pack	Electro EM-1257	BTLI2
R301	Resistor	5.6K, 1/8W, 5%		RECC562B21

SECTION 6
DIAGRAMS

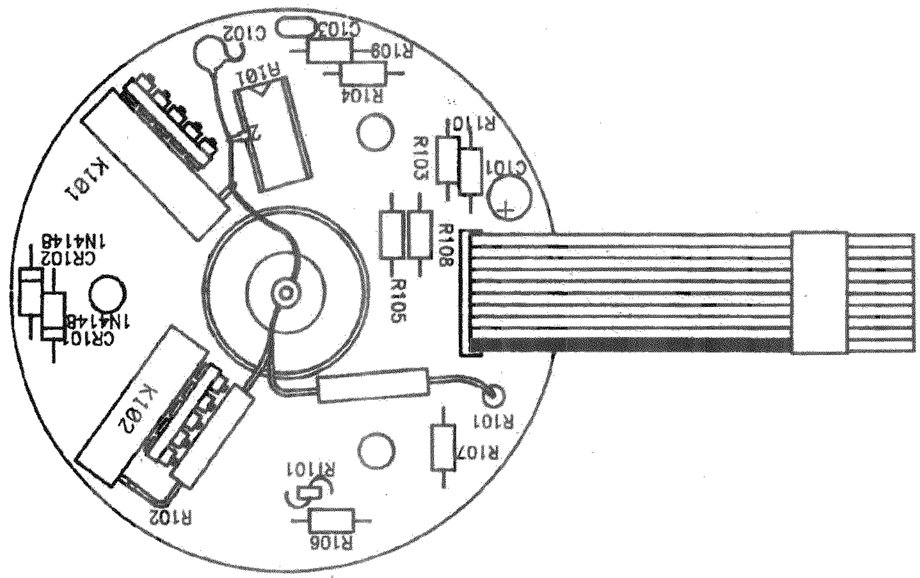

Figure 6-1. Detector Board Component Layout, 11547-C03

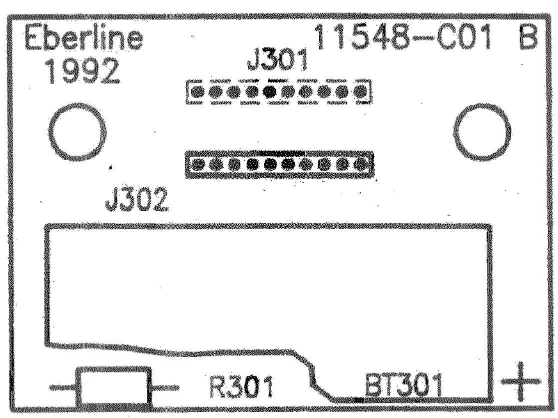

Figure 6-2. Con . nectorlBattery Board Component Layout, 11548-C03

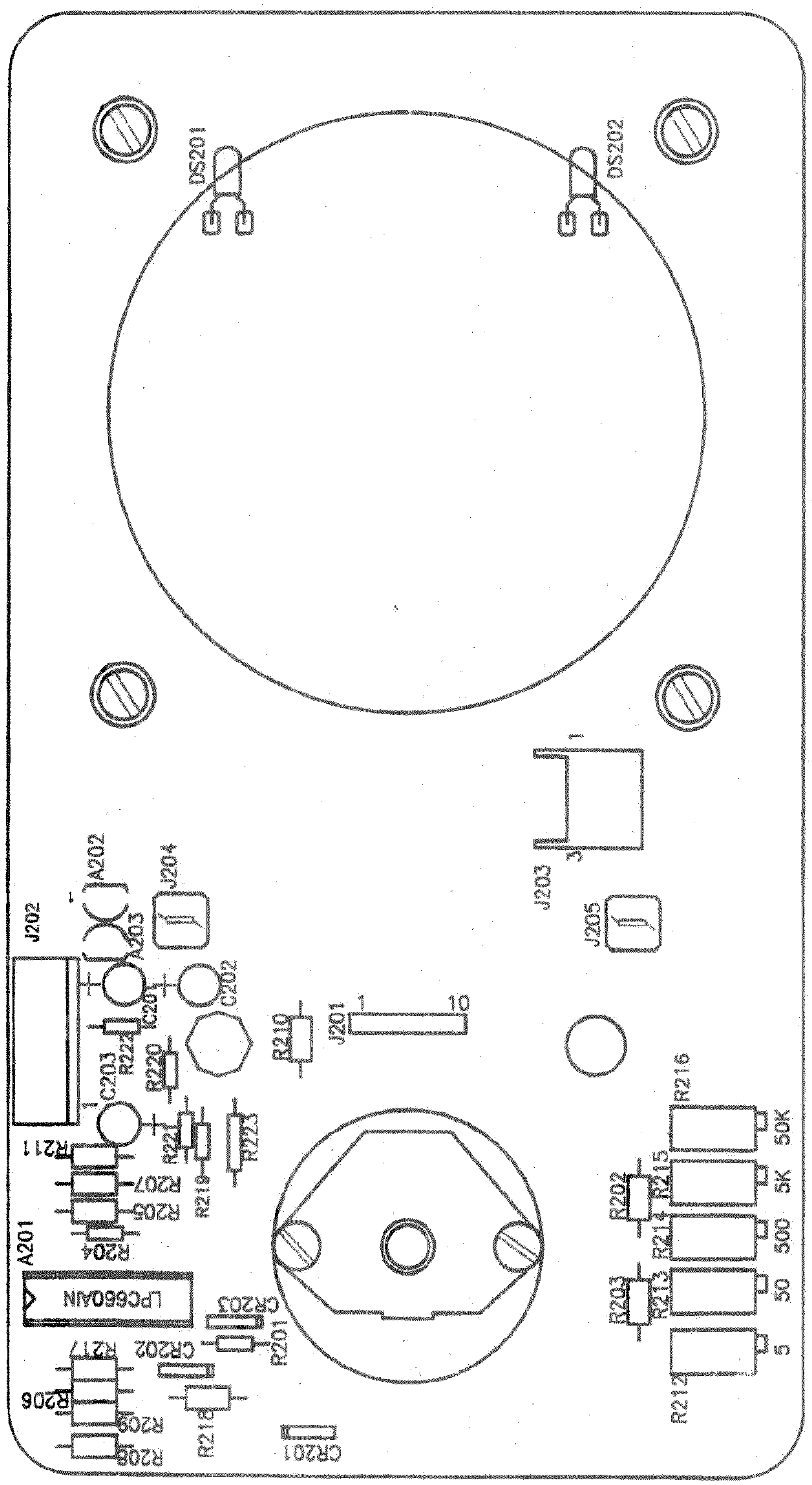

Figure 6-3. Main Circuit Board Layout, 11546-03

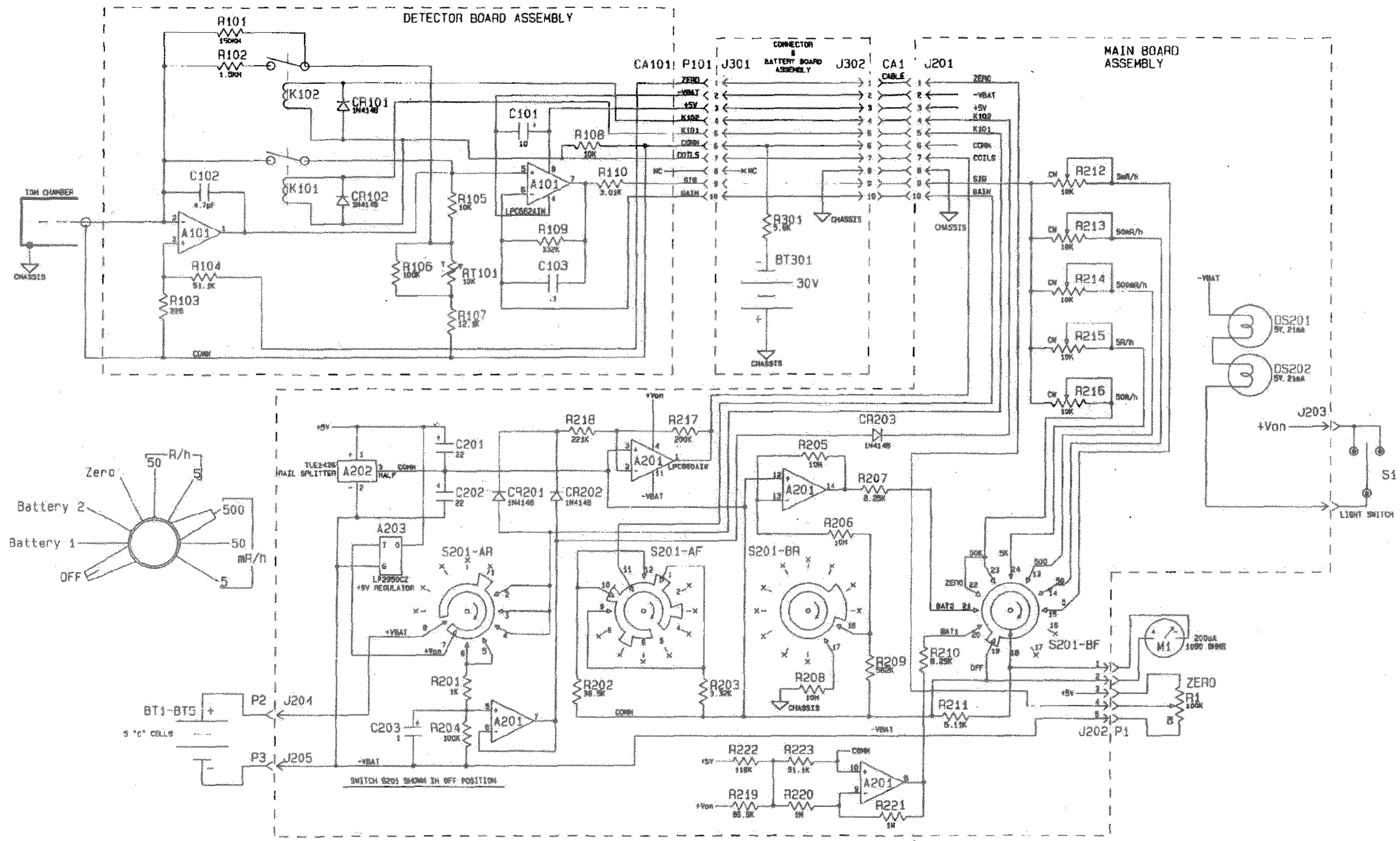

Figure 6-4. General Schematic, RO-20, 11498-DO2